

Imperial College
London



Department of Electrical and Electronic Engineering



Postgraduate Information: 2004-05
MSc in Control Systems



1 October 2004

Dear Control MSc Students:

Welcome to the Control & Power Group's MSc Programme on Control Systems.

The information presented with this letter in the Control MSc Welcome Pack should give you a better understanding of our course and environment. We shall be distributing more information by email as the course progresses.

Apart from the lectures, the main mode of communication between staff and students is email. It is very important that you activate your email accounts immediately and check your email at least once a day – otherwise you will, sooner or later, miss something important. It might be a lecture, a piece of coursework that has to be done or (at the other extreme) a party.

If you need help with an aspect of a lecture or problem sheet and do not speak to the lecturer concerned at the end of the lecture, please email your question to the lecturer who will then either provide help by email or arrange to meet you to discuss the problem. If you have academic problems that cannot be handled in this way, or have problems of a personal nature, then please contact your personal tutor first. If more help is needed, Section 9 should be useful. Please feel free to contact the MSc Course Director at any time. Contact details for all C&P Group staff are given in Section 16.2.

For all administrative queries, please contact Michelle Hammond (Room 1110, E&EE Building, m.hammond@imperial.ac.uk).

During the last few years, the staff interested in control and those interested in power have come together to form the Control & Power Group, with many beneficial results. One of them is lecture course C3.2: Modelling and Control in Power Engineering which is well worth your attention.

This handbook will be available on-line in the near future and the on-line version will be updated when appropriate throughout the year. The location of the relevant site will be emailed to you soon.

We hope you will enjoy the 'C & P experience' and being a member of the postgraduate community in the Department and College; and that you will be very successful in your studies, exams and projects.

John Allwright
Control MSc Programme Director
Room 1111A, E&EE Building
jca@imperial.ac.uk

IMPERIAL COLLEGE LONDON
Department of Electrical and Electronic Engineering

CONTROL SYSTEMS MSc. PROGRAMME HANDBOOK
2004/2005: Release 1.00 – 30 September 2004

Please keep this handbook and read it carefully.

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2. Start of Session Arrangements 2004-2005

MSc FRESHERS

- Note:** The Control MSc Administrator is Michelle Hammond @ Room 1110, Electrical and Electronic Engineering Building (go to Level 11, turn right as you leave the central lifts; Michelle's office is at the far end on the right).
- Emails:** Once you have activated your email account, you can read and send emails and use the Intranet etc. on any computer in the MSc Laboratory (Room 303, EEE Building). This can only be done after registering (see below) and visiting Michelle with the registration slip.

Sunday 3rd October 2004

- 11:15 am** **Welcome to new International Students**
Great Hall, Sheffield Building

Monday 4th October 2004 (the start of Week 1)

Registration with Imperial College London for the MSc in Control Systems:

All day 10.00 am - 5.00 pm
Main Dining Hall, Level 1, Sheffield Building (see map on page 9)
(keep your Registration Slip because you will not be able to obtain your Welcome Pack and Computer Login Address without it).

Security ID card

All day 10.00 am – 5.00 pm
Have your photo taken for you ID card in the Ante Room, Level 1 Sheffield Building. You will be able to collect your card later in the week: an email message will tell you when and where.
(You should carry the card with you at all times: it will enable you to open the doors to the EEE Building after normal working hours, enter the main library etc.)

- Obtain a locker:** Go to the MSc Room 404 (the MSc Study Room), choose an empty locker, note its number and go to Danny Harvey in Room 303 to register that the locker is yours. You will need to buy a padlock to lock the locker. Lockers will be registered on a first-come first-served basis.

- 2:00 pm** **Departmental Welcome Meeting to new EEED Postgraduate and MSc students**
Professor DJN Limebeer (Head of Department),
Mr DM Brookes (Deputy Head of Department and Director of Postgraduate Studies),
Dr I Jaimoukha (Postgraduate Tutor)
Room 408, 4th floor, Electrical Engineering Building

3:00 pm Please go to Michelle Hammond in EEE Room 1110 with your Registration Slip. Possession of the slip will enable you to collect from Michelle your Welcome Pack, and Computer Login Address; and to arrange with Michelle a time to meet the Control MSc Course Director and your Personal Tutor.

Tuesday 5th October 2004

Registration and Security ID card if you did not register on Monday, 4th October 2004

Please register at the Student Records Office, Room 343, Sheffield Building. For your security swipe card, go to the Main Security Office, Level 1, Sheffield Building.

All Day **Freshers' Fayre**
Level 1 and 2 of the Sheffield Building, Queen's Lawn
An opportunity to find out about the many student societies and clubs that flourish at Imperial College.

Wednesday 6th October 2004

11:00 am **MSc Control Systems Central Library Tour**
Assemble in the foyer of the Central Library (just through the revolving doors) at 10:55 am

2:00 pm Continuation of MSc Control Systems Personal Tutor Meetings
If you have not already done so, please see Michelle Hammond (Room 1110) to arrange a time for your short introductory meeting with the MSc Course Director and your Personal Tutor.

There are no Control Systems MSc lectures in Week 1.
It might be wise to read the revision material on Linear Algebra that is in the welcome pack during Week 1.

Monday 11th October 2004

This is the start of Week 2. MSc classes begin according to the timetable on page 10.
For week 2 and later, check the timetable has not changed by looking at the latest version on the Intranet by going to the Electrical and Electronic Engineering Homepage. Under the heading General is the link to the Intranet. Activate this link and you will find a link to Autumn Timetable. Click on it to see the timetable. Scroll down the list on the left hand side to Control MSc. Clicking on it will enable you to see your timetable. See Section 16.4 regarding computers you can use for email.)
Note carefully the week in which each course begins.

Important events early in the term:

Tuesday 12th October 2004

4.00 pm onwards **Graduate School of Engineering and Physical Sciences (GSEPS)**
GSEPS role is the provision of academic training courses in transferable skills.
Both PhD and MSc students are welcome to attend.

Welcome Event:
Great Hall, Sherfield Building

4.00-5.30 pm **Welcome Address**

Introduction to the Graduate School
Professor Julia Higgins

Introduction to the Transferable Skills Courses

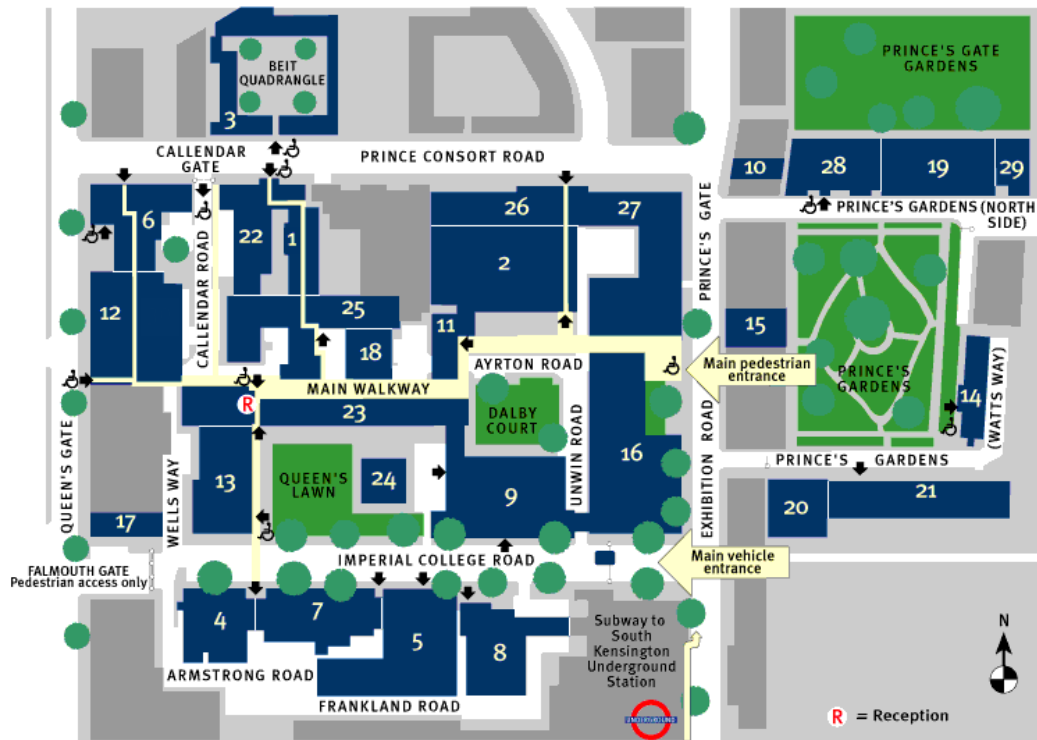
'Life as a Research Student'
Professor David Stuckey

5.30-6.30 pm **Drinks Reception**
Sherfield Ante room and Main Dining Hall

Wednesday 13th October 2004

1.00 – 2.00 pm **MSc Students Careers Talk**
Dr Neil Harris
'Getting a Job' for MSc students
Gabor Seminar Room, 611
Electrical and Electronic Engineering Building

3. South Kensington Campus Map



Key places

- 3. Beit Building – Imperial College Union
- 11. Electrical Engineering Building
- 13. Imperial College and Science Museum Libraries
- 23. Sheffield Building – (Administration) – **please enter through the main doors at the Western end**
 - Level 1: Reception, Bank, Catering, Main Dining Hall, Security
 - Level 2: Great Hall, ICU Shop, Junior Common Room, QT Snack Bar
 - Level 3: Registry – 343 Student Records Office





5. Address to use for Incoming Snail Mail

Mail for all MSc students will be delivered to the pigeon holes on Level 1, beneath the central stairs that descend from Level 2,. The MSc Control Systems Programme has a pigeon hole on the right hand side and this is where your mail should go.; however check the undergraduate pigeon holes on the left because sometimes MSc mail gets stuffed into them by mistake..

Please tell people likely to send you mail that the address to use should be of the form:

Name
Control MSc
Electrical Engineering Building
South Kensington Campus
Imperial College London
London SW7 2AZ

6. Departmental Postgraduate Administration

	<p>David J.N. Limebeer Head of Department</p>
	<p>Mike Brookes Director of Postgraduate Studies</p> <p>Mike has overall administrative responsibility for the Department's postgraduate affairs including monitoring the progress of every postgraduate student towards MPhil/PhD transfer and submission. He is responsible for ensuring that all College regulations are applied appropriately in the Department</p>
	<p>Imad Jaimoukha Postgraduate Tutor</p> <p>Imad is responsible for the welfare and training of research students. Every new student will be invited to meet with the Postgraduate Tutor in his or her first Term. Thereafter they will meet once each year. Outside of these appointments Imad is available to discuss welfare or postgraduate affairs on Mondays between 1.00 pm and 2.00 pm. If you need to meet with Imad to discuss any difficulties with your studies or if you have personal circumstances which are hindering your progress you can e-mail him jaimouka@imperial.ac.uk to arrange an appointment or contact him via the postgraduate office Room 614 or by e-mail a.hough@imperial.ac.uk.</p>
	<p>Anne Hough Postgraduate Office, EEE Room 614</p> <p>Anne is always available to give advice on postgraduate matters and provide the required forms for Transfer, Exam Entry, Interruption of Studies etc. a.hough@imperial.ac.uk</p>

7. The Postgraduate Staff/Student Committee

This provides an opportunity to make your feelings and views heard. The Committee consists of representatives from each research group, each MSc course, the Director of Postgraduate Studies and the Postgraduate Tutor and it meets once a Term. Issues that have been discussed at previous meetings include postgraduate training, introduction of new college regulations, provision of a postgraduate common room and social opportunities.

Representatives are elected by their fellow students. You will be asked to nominate a student from your MSc course as your student representative in the early part of the Autumn term.

It is very important that the administration of the Department understands the views of its postgraduate community, so please try to take an active part in this process.

8. Reporting Absences from College

Full time students must notify the Postgraduate Office, preferably by email to a.hough@imperial.ac.uk if they will be away from College for more than 7 days, with the exception of the official College closures at Christmas and Easter.

9. Sources of help

ACADEMIC MATTERS

In any one lecture course or subject:

The **Lecturer** is the expert. Lecturers are willing to help when approached, but of course they cannot help all students individually, so be reasonable in your requests.

Your **Personal Tutor** is knowledgeable about most subjects, but possibly not an expert in every one. He or she is also good at advising on study methods generally.

If study pattern or motivation is the problem:

The College publication "**Learning to Learn**" contains some really helpful advice on how to improve your study efficiency. If you find organising your studies a problem, try it.

If you and others wish to complain about some aspect of the course:

Individual lecturers will listen to reasonable argument. Try them first. In other cases, the elected **Student Representatives** are delegated to approach staff. If a really serious problem arises, please tell the MSc Course Director..

PERSONAL ISSUES

Your **Personal Tutor** is there to give advice, and is normally your first port of call. Send an email to arrange a time to meet.

Advisor to Women Students, Jane Horrell j.horrell@imperial.ac.uk.

A specific point of contact for women students in the department, who can be consulted about any difficulties which a student may not wish to discuss with their Personal Tutor.

The College's **Student Counselling Service** is available to all students by appointment. The Service is

confidential. The counsellors are David Allman (full-time) and Sarah Cooke (part-time). For an appointment ring 0171 594 9430 (in College, ext. 49430) or email d.allman@imperial.ac.uk or sarah.cooke@imperial.ac.uk.

Exam Stress Workshops are run by Claudio Calvi in the Health Centre, usually at the end of Autumn and Spring terms. Information is given on the Health Centre's website (address below).

The College **Health Centre** is open every weekday 08.30-12.00, 13.00-18.00 *except* Tuesday afternoons, and has a full range of services. <http://www.imperial.ac.uk/healthcentre>.

FINANCIAL PROBLEMS

Sometimes financial worries are more easily laid aside if there is someone to discuss them with. In addition to your personal tutor, the Senior Tutor, and your Bank, the College has a small group of staff in the Student Records Office on Level 3 of the Sherfield Building who are willing to help. They deal with funds available to students in cases of financial hardship and problems with payment of tuition fees. They may be contacted in normal working hours.

10. Health and Safety

Health and safety is an important aspect of our lives and one for which we are all responsible. It is particularly important in a specialised environment like Imperial that we maintain the highest health and safety standards.

Full details of the College Health and Safety guide is now located on the College web site and can be found at the following http address: <http://www.doc.imperial.ac.uk/~cdsm/safety/>

24 hour emergency number is 4444. In all emergencies, call **4444**, stating which building and room number/location you are in and also the nature of the emergency.

Fire Alarms

Sounder is continuous.

Evacuate immediately if sounder heard.

Evacuation via staircases, North, South and Central – **DO NOT USE THE LIFTS**

Assembly Point is outside the level 2 entrance of the building – away from the building, or on the Queen's Lawn.

The fire alarm test is on Wednesday mornings at 8.30 am – short bursts **NOT** continuous.

Discovering a Fire – Raise the alarm by nearest fire call point or call **4444** giving the building name and room number/location and evacuate the building. Warn any people nearby. Leave the area immediately. Close all doors behind you. Use the appropriate fire extinguisher but **DO NOT PUT YOURSELF AT RISK.**

First Aid

There is a list of First Aiders on each floor located at the Passenger lifts and the Goods lift. Please make a note of where the nearest one is to you.

In all emergencies, call **4444**, stating which building and room number/location you are in and also the nature of the emergency.

Security

The Electrical Engineering building is open from 7.30 am to 7 pm in the evening. Please make sure that your personal belongings are kept safe and secure – **do not leave them unattended.**

Smoking

The Electrical Engineering Building is a no smoking building. If you wish to smoke, please go outside the

building and use the bins provided.

Food and Drink

No food or drink is to be taken into the lecture/teaching rooms or the teaching labs.

The College Health and Safety Guide is available at: <http://www.doc.imperial.ac.uk/~cdsm/safety/>

If you notice anything unsafe or have any questions contact:

John Grover

Technical Services Manager/Departmental Safety Officer

Room 202

Telephone: x46161 Mobile: 07753739769 Speed dial: 57802

E-mail: j.grover@imperial.ac.uk

11. Staying Healthy with your Computer

TAKE BREAKS

Intersperse with other work. Take a five minute break every hour and don't spend a whole day on computer-based activities. Netsurfing or playing computer games does *not* count as a break.

KEEP YOUR DESK TIDY

Avoid cluttering it up with books, papers etc. Make sure you have enough clear space to operate your mouse easily and to access your keyboard. Keep most frequently used items close to hand to avoid stretching.

ADJUST YOUR EQUIPMENT TO SUIT YOU

Set your screen to a comfortable height. Sit face-on to your screen to avoid any twist in your spine. Ensure sufficient room to rest your hands in front of keyboard when not keying. Adjust your seat height so your arms are horizontal to the keyboard and avoid flexing/extending wrists. If you use a laptop, work with it on a table, never on your lap. Ensure room for your feet to rest under your desk, using a footrest if necessary

GET COMFORTABLE

Adjust the seat height and back tilt/height to fit you. Sit back when you are thinking, rather than staying hunched over your screen. Use a soft touch when keying and avoid flexing your wrists. Give your eyes a comfort break too. Look away from your screen or close your eyes when thinking. Avoid staring at the screen and throw in a few extra blinks as natural blink reflexes are often unconsciously suppressed.

DON'T IGNORE SYMPTOMS

If your arms or shoulders start aching or tingling, take a break and re-organise work to give yourself more breaks in future. If symptoms persist or keep recurring, contact your occupational health (OH) service for help.

MAKE USE OF THE EXPERTS

Fabienne De Swardt in EEE Room 107A can give advice on computer ergonomics and can also give details of the health and safety training sessions held by the College Safety Unit. Students can arrange

vision screening through the College Health service who can also advise on Cumulative Trauma Disorder.

12. Resources

LIBRARIES

Departmental Library

The Departmental Library can be found on Level 6 of the Department of Electrical and Electronic Engineering and holds the research postgraduate collection.

Hours:

Term: Mon-Fri 9.30 am – 5.30 pm
Vacation: Mon-Fri 9.30 am - 5.30 pm

Staff:

Liaison Librarian: Ellen Haigh
Senior Library Assistant: Don Bishop
Library Assistants: Sara Swindlehurst and Elizabeth McCormack

The library holds over 8,000 books arranged by topic, the majority of which are available for loan. It holds over 4,000 volumes of periodicals and receives over 200 print titles.

There is a collection of over 1,900 MSc, PhD and DIC theses and a few notable undergraduate projects. Theses are available for loan. There are four networked PC's available to access electronic material.

Loan Services

You may borrow items from all campus libraries using your Imperial College swipe card. Using the Imperial College online catalogue, input your swipe card barcode number and your PIN number and material can be reserved and a check can be made to see which items have been borrowed and requested. Reserve and recall notices are sent to you by e-mail. You can renew your material and request items on Inter-Library Loan through the Imperial College online catalogue.

You may borrow up to 30 books and 4 restricted loan books/CDs.

Electronic Information Services

Imperial College subscribes to thousands of electronic journals, databases, and databanks. Use the Imperial College Library website for lists and to access them:
<http://www.imperial.ac.uk/library> Use is free to members of the College.

Other Libraries

The College Central Library holds the multiple copies of textbooks and subjects deemed interdisciplinary. Also, several departments have their subject collections there, such as Medicine, Computing, and Management. Students may also visit other Departmental Libraries e.g. the Maths Library for periodicals and books. The Haldane Collection holds fiction and non-fiction books along with music CDs available for loan.

Mobile Phones

If you own a mobile phone, you must keep it turned off while in any lecture theatre, teaching laboratory or Library.

Library tours

Tours of the Departmental and Central Libraries have been arranged for Wednesday 6th October at 11:00 am. No booking is required. Please meet in the Foyer of the Central Library (through the revolving door) – the Central Library is Building 13 in Section 3. If you have any queries, please contact Ellen Haigh on ext 46182 or email e.haigh@imperial.ac.uk

MSc Study Room

There is a study room with computers available to all MSc students on level 4 – Room 404.

Computing Facilities

You will mostly use the computers in the MSc study room but there are additional departmental computing facilities including an open access lab in Room 305.

Laboratories

The MSc laboratory is on the third floor Room 303 and is managed by Danny Harvey.

Photocopying facilities

Photocopying facilities are available on Level 1 (there is a sign “Reprographics” above the door). You will need to obtain a photocopying card to enable you to use the machines. These can be purchased from the Stores on Level 1, at the back of the Reprographics Room.

Noticeboards

You should consult the notice boards concerning your course regularly. The notice board is located in the MSc Lab, Room 303, Level 3.

Useful Website Addresses/telephone numbers etc.

Library catalogue – <http://www.imperial.ac.uk/library>
Departmental Timetable – <http://intranet.ee.imperial.ac.uk/timetable/Autumn04/index.html>
access via the Department homepage- <http://www.ee.imperial.ac.uk/> – click *taught courses*.
Imperial College Home Page – <http://www.imperial.ac.uk/>
Research Group web sites are accessible via the Departmental Homepage.
Imperial College Union Clubs and Societies – (020) 7594 8066
Imperial College Union – (020) 7594 8060
Electrical & Electronic Engineering Society (EESoc)
C&GCU Faculty Research Student Representative - Darran Specter darran.specter@imperial.ac.uk

13. English Language Skills

It is strongly recommended that all non-native-English-speakers take advantage of the English language courses on offer to help them improve their written English in preparation for writing their MSc project reports.

The English Language Support Programme (ELSP) offers classes to students and members of the College who are not native speakers of English. The majority of these classes are free of charge to students and are also offered at a small charge to partners.

There are three types of class: General, Pronunciation, and Writing Academic English. If necessary, students can attend more than one class. The English programme also offers a writing clinic for students preparing papers, coursework and theses where they can have their written English checked before submission to a supervisor.

The classes start at the **beginning of the third week of term** and run until the end of the Spring Term. Most are for 2 hours a week, Monday to Thursday 6.00 to 8.00 pm. Classes are held on Level 3, Mechanical Engineering building, email elsp@imperial.ac.uk.

If you are interested in joining a class or have been told by your department that you must attend English classes, the first step is to come to Room 220, Mechanical Engineering Building for one of the **English classes test and registration sessions** at the beginning of the academic year. They are as follows:

Wednesday 6th October at 5.00 pm

Thursday 7th October at 6.00 pm

Monday 11th October at 6.00 pm

If you miss these please email elsp@imperial.ac.uk for details of the next ones. More information about English classes can be obtained from their website:

<http://www.hu.imperial.ac.uk/english/>

14. The Graduate School of Engineering and Physical Sciences (GSEPS)

The principal role of the Graduate School of Engineering and Physical Sciences (GSEPS) is to monitor and enhance the quality of postgraduate education in the Faculties of Engineering and Physical Sciences and the Humanities Department and the Business School. All postgraduates within these Faculties and Departments are members of the Graduate School.

The Graduate School also organises a number of social activities throughout the year. These include distinguished guest lectures and a research symposium. These events are intended to promote intellectual discussion and exchange of ideas across disciplines. A regular electronic newsletter cascaded via Departments keeps members informed of events and activities.

Further information about the Graduate School can be found online at <http://www.imperial.ac.uk/gradepts> or contact the Graduate School Administrator – sophie.white@imperial.ac.uk.

15. Postgraduate Skills Training organised by GSEPS

Introduction to the Transferable Skills Programme

A major part of the Graduate School's role is the provision of academic training courses in transferable skills. PhD Research and MSc students are welcome to attend these courses and details of the courses and how to reserve a place can be found in the GSEPS transferable skills courses booklet.

The acquisition and development of generic research and transferable skills is an important part of postgraduate training. The GSEPS Academic Training Committee has developed a formal Transferable Skills Training Programme to run alongside and complement existing local training programmes. This is to ensure that all graduate students have an opportunity to undertake an element of personal skills training during their time at Imperial.

The Academic Training Committee has identified key transferable skills in which training will be provided. Those which are considered to be core skills are listed in group "A", with additional workshops listed in group "B".

From October 2003 all new research students within the Faculties of Engineering Physical Sciences and the Business School* will be required to take three transferable skills courses from a list of seven core subject areas (the A List Courses). These courses are:

A List of Courses:

- Information Retrieval Lecture
- Technical Writing Lecture Series
- Teamwork Three Hour Workshop or Teamwork Two Day Workshop
- Personal Organisation & Effectiveness Workshop or Time Management Workshop or
- Effective Communication Workshop
- Technical Presentations Fishbowl
- Professional Ethics in Science: Research Ethics Workshop
- Thesis Writing & Completing the PhD Lecture

Courses vary in length and format from one hour lectures to two day workshops. Please see the individual course descriptions for full details.

In addition to these courses, there is also a wide range of B List or Optional Courses for all students.

B-list of courses

- *Advanced Assertiveness: Status Work*
- *Assertiveness*
- *Commercialisation of Research*
- *Creativity & Ideas Generation*
- *The Information Landscape: Introducing ISI Web of Knowledge*
- *The Information Landscape: Keeping Ahead in the Information Game!*
- *Intellectual Property Rights*
- *Interpersonal Skills*
- *Interview Practice Workshop with Video Playback*
- *Motivation*
- *Myers Briggs Workshop I (Introduction)*
- *Myers Briggs Workshop II (Advanced)*
- *Negotiation and Influencing Skills*
- *Negotiating Skills for Scientists and Engineers*
- *Negotiating Skills for Scientists and Engineers*
- *Networking*
- *Project Management*
- *Presentation Skills Two Hour Workshop*
- *Reference Manager*
- **Further Statistics**
- *Tackling A Literature Review*
- *Technical Writing Lecture Series Workshop*
- *Technical Writing Lecture Series Fishbowl*
- *Technical Writing Two Hour Workshop*

Masters' students and research students in their second or above year of study are welcome to attend any of the courses – although they should note that priority for A List courses will be given to first year research students.

The most popular courses will be run on more than one occasion and students will be given the opportunity to register for courses as they become available. As there are limited places on each session you should book your place as early as possible.

TRAINING COURSES ARE PROVIDED FREE OF CHARGE FOR YOUR BENEFIT. IT IS IMPORTANT THAT YOU ATTEND THE TRAINING SESSIONS. ATTENDANCE WILL BE RECORDED.

Cancellations should be notified as soon as possible so that your place can be given to another student. No cancellation charges will be made except where a student does not attend a course without

giving 3 working days prior notice.

16. The MSc Programme in Control Systems

16.1 Introduction

These notes are designed to provide you with most of the information that you need to know about the structure of the component courses and the process of examination. The formal specification of the MSc programme is given in Section 16.15.

The programme provides a broad coverage of material, and we encourage students to attend lectures from each of the four subject sections into which it is divided. For examination purposes, however, some flexibility is possible in that students are required to satisfy the examiners in 7 subjects only out of the 11 examinable courses. A more detailed description of the requirements for being awarded the MSc is given in Section 16.5.

Most lectures are held in the E&EE Building. In addition to the course lectures, there is a programme of seminars by outside speakers, which we also encourage you to attend. These are generally held in the Seminar Room (level 11 E&EE Building) or in the Centre for Process Systems Engineering (Roderic Hill Building, top level).

16.2 Staff Members Involved in the Programme

	Room:	Tel:	Email:
Michelle Hammond (C&P Group Administrator)	1110	46281	m.hammond@imperial.ac.uk
Dr. J.C. Allwright (Control MSc Programme Director)	1111 A	46283	jca@imperial.ac.uk
Dr. A. Astolfi	1112	46289	a.astolfi@imperial.ac.uk
Dr. D.M. Brookes (Director of postgraduate studies)	811A	46165	mike.brookes@imperial.ac.uk
Dr. P. De Wilde	802	46217	p.dewilde@imperial.ac.uk
Dr. I.M. Jaimoukha (Departmental Postgraduate Tutor_)	1111C	46235	jaimouka@imperial.ac.uk
Professor Kin Leung	612	46238	kin.leung@imperial.ac.uk
Professor D.J.N. Limebeer (Head of the EEE department)	609	46188	d.limebeer@imperial.ac.uk
Dr B Pal	1104	46172	b.pal@imperial.ac.uk
Dr C. Hernandez-Aramburo	1102	46170	c.a.hernandez@imperial.ac.uk
Professor R.B. Vinter (Head of the Control and Power Group)	1110	46287	rbv@imperial.ac.uk
Dr. S. Walsh (ICI)	1110	46281	(for messages)
Dr. G. Weiss (in charge of the Laboratory in Room 303)	1114	46196	g.weiss@imperial.ac.uk

16.3 Programme Structure

The main part of the programme is divided into 4 subject sections, as shown below. The code after the lecturer's name in each listing indicates the term, the number of lectures and the examination status (e=examination only, ec=examination with course work, c=course work only, n=non-examinable).

1. *Deterministic Systems and Optimisation*

C1.1	Optimization	Astolfi	Autumn 20	ec
C1.2	Linear Optimal Control	Astolfi	Autumn 20	ec
C1.3	Discrete-time Systems and Computer Control	Allwright	Autumn 20	ec
C1.4	Stability and Control of Non-linear Systems	Allwright	Spring 20	ec
C1.5	Topics on Control Systems	Astolfi	Spring 10	n
C1.6.	Mathematics for Signals and Systems	Weiss	Autumn 20	ec

2. *Stochastic and Fuzzy Systems*

C2.1	<i>Probability and Stochastic Processes</i>	Leung	Spring 20	ec
C2.3	System Identification	Weiss	Spring 20	ec
C2.4	Fuzzy Systems	De Wilde	Autumn 20	c
3.	<i>On-line Control</i>			
C3.1	Advanced Process Control	Walsh	Autumn 20	c
C3.2	Modelling and Control in Power Engineering	Green/ Pal	Autumn 20	e
4.	<i>Control System Design</i>			
C4.1	Design of Linear Multivariable Systems	Jaimoukha	Spring 20	ec

NOTES:

1. A reasonable familiarity with linear algebra is required for most of the courses. Dr Jaimoukha provides a revision handout.
2. Course C1.5 covers advanced topics of current interest in control systems design, possibly via seminars.
3. Students who wish to revise basic control knowledge can obtain from Michelle Hammond copies of Professor Vinter's undergraduate lecture notes on Control Engineering.

16.4 Study Facilities

MSc Postgraduate Study Areas - Rooms 404 and 303:

The computers in 404 are equipped with a number of software packages, in particular MATLAB, which provides powerful facilities for the analysis of control systems. A scientific word processor and more conventional word processors are also provided. At present most of the computers in Room 404 are being replaced and the room is not yet fully operational again.

You also have free access to the computers and other facilities in the *Communications, Control and Signal Processing Laboratory, Room 303*, except when it is scheduled for undergraduate use. Any piece of course work or project involving equipment will be carried out here.

email: The department will assign you an email address. This is usually in the form:
 $\leq \textit{firstinitial} > . < \textit{surname} > @\textit{imperial.ac.uk}$.

You can read your email on any of the computers available to you.

16.5 Assessment (Exams and Project)

You can choose to be assessed on any N of the examinable courses, where $N \geq 7$.

A mark (out of a 100) is assigned for each course on which you choose to be assessed, whether it is based on a written examination, course work or both. A mark (also out of a 100) is given to you for your project report.

Your *seven best* course marks and your project mark are used to assess you. Suppose these are, respectively, M_1, M_2, \dots, M_7 and P . To be awarded the MSc, it is necessary that

- (a) $M_i \geq 50$ for $i = 1, \dots, 7$
- (b) $P \geq 50$

and that the average of your 7 best course marks is at least 55.7, i.e.

$$(c) \quad \frac{1}{7} \left(\sum_{i=1}^7 M_i \right) \geq 55.7.$$

Consequently it is wise to choose $N > 7$ so that, for example, doing badly on one examination will not affect the average of the best 7 marks. However choosing N too big might not be desirable since it might require your effort to be spread too thinly over too many subjects and this might lower the average of your best 7 marks.

For eight of the eleven examinable courses, 75% of the marks come from the exam and 25% from related course work. The exceptions are 'Advanced Process Control', which is assessed solely by course work, 'Fuzzy Systems', which is assessed by a combination of course work and oral examination, and 'Modelling and control in Power Engineering' for which there is no coursework.

Your project is assessed solely on the basis of your report; there is no oral examination.

Course work

The lecturer sets a date by which time the work has to be submitted. Normally at least five weeks is allowed for the completion of each piece of course work except when coursework consists of several relatively small parts that are issued separately.

You are free to discuss the coursework with other students however, unless it is specified to be group work, **your submission for marking must be entirely your own work. You must not copy any part of another student's work (i.e. you must not copy any part or all of the text, equations, programs, figures or graphs).**

And you must not copy material from any publication without making it clear what you have copied (usually by enclosing the copied material in '' and following it by a reference number such as [5].) There will be serious consequences for you if we detect any copying from another student or any unacknowledged copying from a publication. Please see also the material regarding Plagiarism in Section 16.9 below.

16.6 Examination Timetable

The examinations will take place during the first three or four weeks of Summer Term (23 April – 20 May 2005). *The timetable will be announced during the Spring Term.*

Generally speaking, there is one examination every other week-day. Each examination lasts three hours. Typically, you are asked to answer four out of six questions.

16.7 Calculators in Exams

You will be provided with standard Casio scientific calculators for exams. You cannot use your own calculators. One of the calculators to be provided will be held by Christine Allwright (Level 6, Room 608) and will be available for inspection in March.

16.8 Projects

Your project begins in the Spring Term and lasts until near the end of September.

A project may consist of an integrating review, the use of existing theory in some particular application, investigation of design techniques, a detailed extension of existing theory or a deeper investigation into a laboratory experiment. While new concepts are not required from students, originality of presentation and evidence of understanding in depth are required.

A limited number of projects may be carried out abroad at the universities of Chalmers or Lund in Sweden or at Supélec in Paris. If you are interested in doing such a project, please tell the MSc course Director as

soon as possible since it might take a considerable time to make the necessary arrangements.

Projects will be assigned during the Spring Term. A list of possible topics, proposed by academic and research staff members, will be circulated in advance.

Topics from students based on their own experience or ideas are welcome but should be discussed with a potential supervisor before a formal proposal is submitted.

The regulations allow you to work on your project outside the College for a maximum of five months, in an appropriate environment, provided you maintain suitable contact with a supervisor in the Control & Power Group.

If you are able to arrange to do your project with a company, it is essential that a legal agreement between the Company, the College and yourself is drawn up (regarding Intellectual Property and Confidentiality of the project report) and signed before you start the project. The MSc regulations allow the project report to be kept confidential, but only owing to commercial sensitivity, for a maximum of two years (subject to the agreement of the Appropriate GSEPS Committee) and must be on open access in a College Library after the period of confidentiality is over. It is important that you mention this to a Company when you start discussing the possibility of doing your project with the Company because this might be a major problem for the Company.

Choice of project topics and allocation of supervisors will be finalised during the Spring term, using the results of a questionnaire on which each student lists the four projects of most interest, in order of preference.

Your project is assessed by your supervisor and a further examiner when your project report is submitted at the end of the course. The external examiner might also influence the final mark awarded to your project.

Project reports.

Two copies of these are required. They should be typewritten on A4 size paper; one must be hard-bound, the other bound in soft plastic report cover. Both copies will be retained by the College. The soft-bound version of your project report must be submitted in final form by 19th September 2005; the hard-bound version must be submitted by 30th September 2005. *Failure to comply with these deadlines will mean a 12-month delay in the award of the MSc degree.*

16.9 Plagiarism

An important regulation:

Please note the following University regulation:

“At any examination by written papers taken under supervision, or where the regulations for any qualification provide for part of an examination to consist of ‘take away’ papers, essays or other work written in a candidate’s own time, coursework assessment or any similar form tests *the work submitted by the candidate must be his own* and any quotation from the published or unpublished works of other persons must be duly acknowledged.”

PLEASE TAKE THIS VERY SERIOUSLY when preparing your course work and project reports – and read more about this topic in Section 16.10.

Expansion of the definition of plagiarism currently given in the Freshers' Handbook

You are reminded that all work submitted as part of the requirements for any examination (including coursework) of Imperial College and the University of London must be expressed in your own words and incorporate your own ideas and judgements.

Plagiarism, that is, the presentation of another person's thoughts or words as though they were your own, must be avoided, with particular care in coursework, essays and reports written in your own time. Note that you are encouraged to read and criticise the work of others as much as possible. You are expected to incorporate this in your thinking and in your coursework and assessments, but you must acknowledge and label your sources.

Direct quotations from the published, or unpublished, work of others, from the internet, or from any other source, must always be clearly identified as such. A full reference to their source must be provided in the proper form and quotation marks used. Remember that a series of short quotations from several different sources, if not clearly identified as such, constitutes plagiarism just as much as a single unacknowledged long quotation from a single source. Equally, if you summarise another person's ideas, judgements, figures, diagrams or software, you must refer to that person in your text, and include the work referred to in your bibliography. Departments are able to give advice about the appropriate use and correct acknowledgement of other sources in your own work.

The direct and unacknowledged repetition of your own work which has already been submitted for assessment can constitute self-plagiarism. Where group work is submitted, this should be presented in a way approved by your department. You should, therefore, consult your tutor or course director if you are in any doubt about what is permissible. You should be aware that you have a collective responsibility for the integrity of group work submitted for assessment.

The use of the work of another student, past or present, constitutes plagiarism. Where work is used without the consent of that student, this will normally be regarded as a major offence of plagiarism.

Failure to observe any of these rules may result in an allegation of cheating. Cases of suspected plagiarism will be dealt with under the College's Procedure for Dealing with Examination Offices and may result in a penalty being taken against any student found guilty of plagiarism.

16.10 Late Submission and Deferral

Any project or coursework component that is submitted late will be accepted only at the discretion of the examiners and may attract a penalty of up to 4% per day. Failure to submit a required piece of work or to attend a required examination other than on grounds of illness, or the death of a close relative, may result in a candidate being failed in the examinations as a whole and therefore being required to retake **all** elements the following year.

Permission to defer the submission of a piece of work or the taking of an examination is only given in exceptional circumstances and requires the written agreement of the course organiser and of the appropriate College committee.

16.11 Registration and Notification of Results

Registration.

Students are reminded that their responsibility to comply with current regulations for registration for the MSc and DIC degrees. European exchange students not registered for the degree are eligible for IDIC diploma. Details of the regulations can be obtained from the Registry, Sheffield Building.

Notification of results

You will be told whether you have passed or failed your exams before the summer term. Your final results will not be available until after an Examiners' Meeting in early November 2005. However, provisional versions of your exam results can be made available to those requesting references, on a confidential basis, where these are required for applications for jobs, research, etc.

London University will send you an official transcript of your results in late Autumn 2005.

16.12 Syllabus

The main topics covered are: (1) the modern theory of linear dynamical systems, based largely on state variable methods; (2) the story of stochastic modelling and control and its application to the design of control systems for noisy processes; (3) the implementation of computer control, and (4) H_∞ methods and other techniques for the design of multivariable systems. Undergraduate courses in elementary feedback control systems can be taken concurrently by students with no background in this area. Additional non-examinable courses in topical subjects such as intelligent autonomous control and neural networks are also available to students.

1. Deterministic Systems and Optimization

C1.1 Optimization

DR J A ASTOLFI

20 lectures in the Autumn Term

This course introduces both the theory and algorithms of optimization. Applications to control and other fields are outlined. Topics covered are selected from: linear least-squares error problems; approximation theory; unconstrained and constrained differentiable optimization; methods using duality; linear and quadratic programming; global optimization methods; simulated annealing.

C1.2 Linear optimal control

DR A ASTOLFI

20 lectures in the Autumn Term

State-space models for linear control systems. Linear system theory: stability; controllability and observability; pole assignment; full and reduced-order observers; Formulation of optimal control problems. The linear/quadratic (LQ) regulator problem for finite and infinite time horizons; properties of the matrix Riccati equations. Use of the LQ regulator in multivariable control system design.

C1.3 Discrete-time systems and computer control

DR J C ALLWRIGHT

20 lectures in the Autumn term

Aspects of digital signal processing relevant to modelling and the implementation of digital controllers are studied using the Z, Delta, W and discrete-time Fourier transforms. Discrete-time systems are analysed and synthesised using root-locus. Nyquist and state-space techniques, bearing in mind the necessity for bounded-input bounded-output stability, small tracking error and robustness.

C1.4 Stability and control of non-linear systems

DR J C ALWRIGHT

20 lectures in the Spring term

For non-linear systems, methods for determining stability and designing stabilising controllers are studied using state-space (Lyapunov theory, variable structure analysis), function space (small gain theorem, passivity) and frequency-domain (Popov and circle criteria, describing function) methods. Model reference adaptive control is treated using the passivity approach.

C1.5 Topics in control systems

DR A ASTOLFI

10 lectures in the Spring term (not examined)

A seminar-type course covering topics of current interest in control systems design and analysis. The subject matter of this course will vary from year to year, but will typically include material on geometric non-linear control, non-linear stabilisation control applications and fuzzy control.

C1.6 Mathematics for signals and systems.

DR G. WEISS

20 lectures in the Autumn Term

Vector spaces, independence, dimension, sequence spaces, analytic functions, normed spaces, inner products, Hilbert and Banach spaces, Weierstrass theorem, completion, L^p spaces, essential supremum, H^p spaces on various domains, boundary traces of H^p functions, span, orthogonal complement, closure, orthonormal basis, Fourier series, bounded linear operators, their norm, orthogonal projectors, isometric and unitary operators, Z and Laplace transforms, convolution, Paley-Wiener theorem (discrete-time and continuous-time versions), shift operators, time-invariant operators, Fours-Segal theorem (discrete-time and continuous-time versions), linear systems, transfer functions, band-limited functions, sampling theorem.

2. Stochastic and Non-Deterministic Systems

C2.1 Probability and stochastic processes

PROFESSOR LEUNG

20 lectures in the Spring term

Axiomatic basis of probability theory. Conditional probability and independence. Random variables and probability distributions. Expectation, moments, characteristic functions. Vector random variables. Sequences of random variables. Stochastic processes. Stationary processes: auto-correlation and cross-correlation; spectral density functions; white noise. Linear operations on stationary processes. Difference equation models for discrete-time processes.

C2.3 System identification

DR G WEISS

20 lectures in the Spring term

Dynamical models for time-invariant linear systems: these include FIR, AR, ARX, ARMA, and state-space models. Guiding principles behind least-squares parameter estimation. Various methods for recursive estimation. Experiments for data acquisition and their design. Main concepts of adaptive control. Control laws for adaptive regulation and tracking. Self-tuning and generalised predictive control. The course will have a theoretical flavour and will contain a number of case studies.

C2.4 Fuzzy systems

DR P De WILDE

20 lectures in the Autumn term

In designing engineering systems, a designer has to be able to cope with uncertainty, because there is noise, incomplete information, defective components, conflicting views of experts, etc. The classical way of dealing with this uncertainty is via probability theory. This offers a well-developed framework, but is sometimes difficult. Fuzzy systems provide an intuitive and mathematically simpler alternative to probability theory based on the concept of degree. This is intuitive, because many facts in real life are neither true nor false, but hold to a certain degree. The course covers fuzzy relations, fuzzy optimisation, fuzzy databases, fuzzy control. Fuzzy systems are very popular in Japan, and used in cameras, other consumer electronics, and for control.

3. Online Control

C3.1 Advanced process control

DR S WALSH

20 lectures in the Autumn term

The aim of the course is to introduce the students to practical controller design for a large complicated plant. This course focuses on the design of a control system for a process control challenge system - the Tennessee Eastman problem. 3-4 lectures introduce methods for control structure selection and control system design: RGA, Neiderlinski index, disturbance rejection analysis, degrees of freedom analysis using the singular value decomposition, sequential tuning strategies, dynamic performance limits. The rest of the time is spent working on the project in groups, using a simulation of the plant and design software developed for MATLAB, with tutorials to support the project work. By the end of the course, the students will be able to apply various advanced controller design techniques to large industrial processes.

C3.2 Modelling and control in power engineering

DR T. GREEN and DR B PAL

20 lectures in the Autumn term

Whether in power distribution and transmission or in motion control systems, power engineering deals with challenging control problems. These arise from the high-order, time-varying, non-linear characteristics of the systems. This course looks at two aspects of control engineering in a power engineering context. The first is the use of coordinate transforms to provide system models more amenable to standard control technique. This leads to well industrial important methods such as field orientation (vector) control of induction motors in servo systems. The second aspect is the control opportunities presented in power transmission by very high power electronic power converters coupled with non-linear robust control methods.

This course is suitable for students interested both in system modelling and control applications.

Aims:

To introduce the dq0 transformation of three-phase systems and demonstrate its usefulness in modelling and control of motors, generators and power systems.

To examine the application of modern control techniques and power electronic control actuators to the optimisation and stabilisation of power systems.

Objectives:

Students will be able to:

1. use dq0 analysis to simplify three-phase systems and decouple interaction between phases,
2. demonstrate how field orientation improves induction machine control,
3. apply standard control techniques to dq0 models of power system devices such as VAR compensators, rectifiers and power flow controllers
4. describe the capability of FACTS (flexible AC transmission system) devices in control terms
5. discuss the application of multivariable and robust control to power systems

Syllabus:

Development of the two-axis, rotating reference frame method (dq0 method) of machine analysis; application of dq0 to general three-phase systems, field orientation control of induction machines (via direct and indirect flux vector angle estimation).

Examination of flexible AC transmission systems (FACTS) based on power electronic power converters and control methods applicable to individual power converters and whole systems.

4. Control System Design

C4.1 Design of linear multivariable control systems

DR I JAIMOUKHA

20 lectures in the Spring term

Multivariable system theory; elements of vector and matrix theory, state-space models, matrix fraction descriptions, poles and zeros, internal stability theory.

Analysis: singular values, return difference, sensitivity, complementary sensitivity and robust stability.

Dominance design: diagonal dominance, Nyquist and inverse Nyquist methods, Gershgorin and Ostrowski bands. H_∞ design:

specification of performance objectives, properties of H_∞ controllers, loop shaping, introduction to H_∞ synthesis theory.

Design example: H_∞ control design for high performance aircraft.

16.13 Reading List

*The following list gives the books recommended for each course. 'A' is a recommended text, well matched to the course. 'B' is a supplementary text that is likely to be helpful. **Do not buy any books before speaking to the lecturer concerned.***

C1.1 Optimization

S BOYD (B)
Lecture Notes on Optimization
Electronic pre-print

R FLETCHER (B)
Practical Methods of Optimization
(2nd Edition or later)
Wiley

C T KELLY (B)
Methods for Iterative Optimization
SIAM Publication 1995

D G LUENBERGER (B)
Introduction to Linear and Non-linear Programming
Addison Wesley, 1977

C1.2 Linear Optimal Control

B FRIEDLAND (A)
Control Systems Design
McGraw Hill 1987

E SONTAG (B)
Mathematical Control Theory
Springer Verlag

G STRANG (B)
Linear Algebra & its Applications
(2nd Edition or later)
Academic Press

P. DORATO, C. ADDALLAH, V. CERONE (B)
Linear Quadratic Control: An Introduction

C1.3 Discrete-time Systems and Computer Control

B C KUO (B)
Digital Control Systems
(2nd Edition)
Saunders HBJ

SANTINA, STUBBERUD and HOSTETTER (B)
Digital Control System Design (2nd Edition)
Harcourt Brau College Publishing

R J VACCARO (B)
Digital Control: A State Space Approach
McGraw Hill 1995

C1.4 Stability and Control of Non-linear Systems

B FRIEDLAND (B)
Advanced Control Systems Design
Prentice Hall 1996

E J-J SLOTINE and W LI (B)
Applied Non-linear Control
Prentice Hall

M VIDYASAGAR (B)
Non-linear Systems Analysis
(2nd Edition) Prentice Hall 1993

H.K. KHALIL (B)
Nonlinear systems
Prentice Hall 2002

C1.6. Mathematics for Signals and Systems

W. RUDIN (A)
Real and complex analysis
McGraw-Hill, (3rd Ed.) 1987

H. DYM, H.P. McKean (Ed). (B)
Fourier Series and Integrals
Academic Press Reprint, 1985

B.P. RYNNE, M.A. YOUNGSON, (B)
Linear functional analysis
Springer-Verlag, 2000

H.L. ROYDEJN (B)
Real Analysis
(3rd Ed), Macmillan, 1988

D.C. COHN (B)
Measure theory
Birkhauser Verlag AG, 1993

C2.1 Probability and Stochastic Processes

H STARK and J W WOODS (B)
Probability and Random Processes with Applications to Signal Processing

(International Edition)
Prentice Hall 2001 (paperback)

C2.3 System Identification

K J ASTROM and B WITTENMARK (B)
Adaptive Control
Prentice Hall 1989

R JOHANSSON (A)
System Modelling and Identification
Prentice Hall 1993

L LJUNG (B)
System Identification: Theory for the User
Prentice Hall 1987

C2.4 Fuzzy Systems

T ROSS (B)
Fuzzy Logic with Engineering Applications
McGraw Hill 1995

C3.1 Advanced Process Control

D E SEBORG, T F EDGER, D A MELLICHAMP (A)
Process Dynamics and Control
John Wiley & Sons 1989

C4,1 Design of linear multivariable systems

M GREEN and D J N LIMEBEER (B)
Linear Robust Control
Prentice Hall 1994

J M MACIEJOWSKI (A)
Multivariable Feedback Design
Addison-Wesley 1989

S SKOGESTAD and I POSTLETHWAITE (A)
Multivariable Feedback Control: Analysis and Design
John Wiley 1996

16.14 Careers in engineering for Control Systems MSc graduates:

There will be three events concerning careers during the academic year

- *Getting a job* by Dr Neil Harris, 1.00-2.00 pm on Wednesday 13 October 2004, Gabor Seminar Room, Room 611, EEE Building
- *Practice at psychometric tests used by employers*, 1.00-4.00 pm, 8 December 2004, location to be announced
- *Interview skills*, 1.00 – 3.00 pm, 26 January.2005, location to be announced.

The Imperial College Careers Advisory Service (www.ic.ac.uk/careers), the Institution of Electrical Engineers (www.iee.org.uk) and the Institute of Measurement and Control (www.instmc.org.uk) can provide relevant information and assistance.

The URLs of some organisations which might have suitable vacancies are given below:

Aerospace: www.airbus.com; www.baesystems.com; www.eads.net; www.rollsroyce.com; www.snecma.com

Control, automation and software: content.honeywell.com/uk; www.lotusautomation.com; www.mathworks.co.uk/company; www.ricardo.com/portal.asp

Electric Power: www.abb.com; www.aveva-td.com; www.controltechniques.com; www.edfenergy.com; www.gecareers.com; www.siemens.com; www.turbogenset.com

Advanced transportation: www.daimlerchrysler.com/dccom; www.f1jordan.com; www.ford.co.uk; www.mclarencars.com; www.prodrive.com; www.williamsf1.co.uk

Process Industries: www.airproducts.co.uk; www.bayer.co.uk; www.borealisgroup.com/public; www.bp.com; www.dow.com; www.icigraduates.com; www.m-kagaku.co.jp; www.pg.com; www.shell.com; www.slb.com

16.15 Control Systems MSc Programme Specification

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